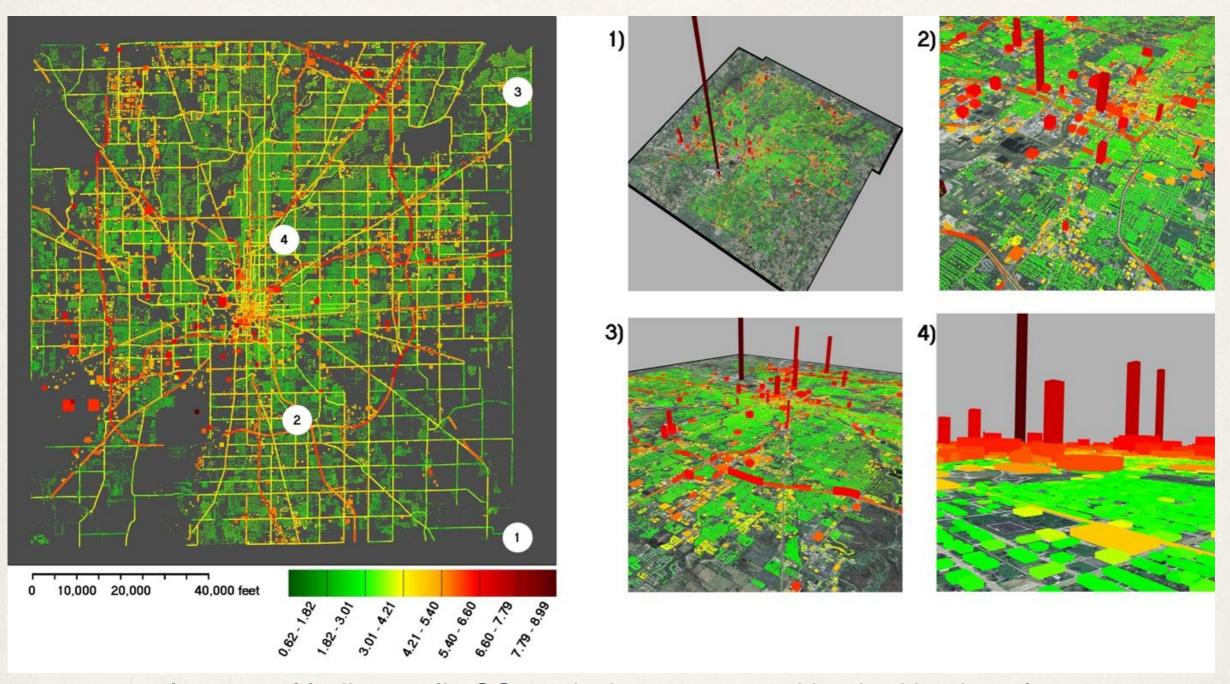


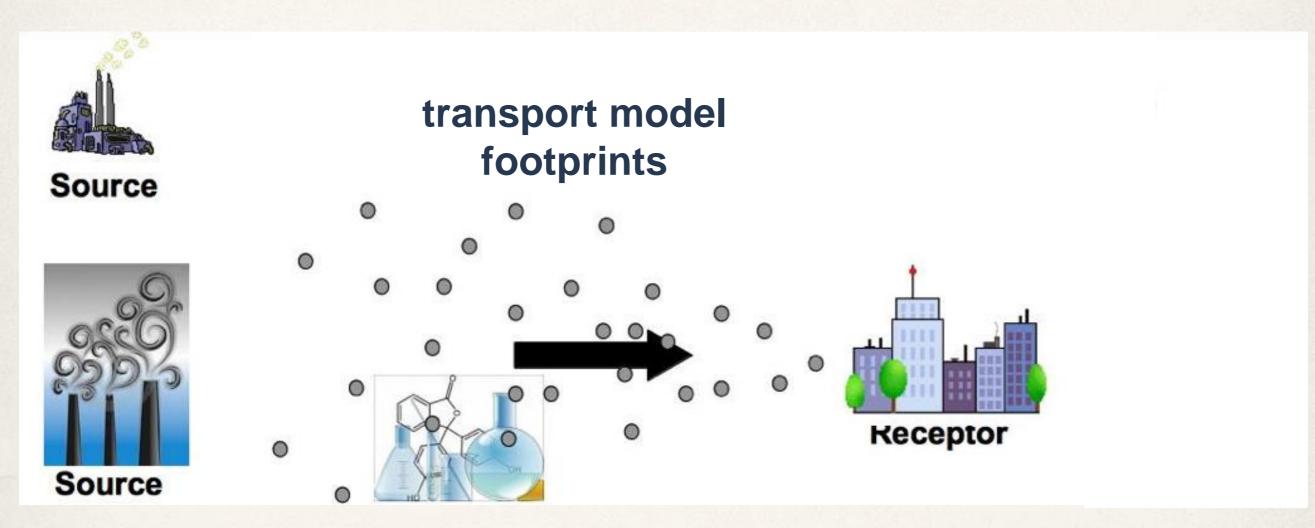


# Indianapolis: First Hestia City



Images of Indianapolis CO<sub>2</sub> emissions generated by the Hestia software

# "Top-down" approach to model carbon fluxes



CO<sub>2</sub> surface fluxes

recorded CO<sub>2</sub> concentrations

#### Obstacles & Amendments to top-down approach

#### Difficulties of "top-down" approach

- footprints \* flux  $\longrightarrow$  CO<sub>2</sub> tower concentrations flux  $\longleftarrow$  X (footprints)<sup>-1</sup> \* CO<sub>2</sub>
- too few towers
- Need to make a priori assumptions about flux magnitude and flux spatial patterns
  - important for posterior estimates of surface fluxes
  - but no standard specification method

#### 

A coherent, systematic, atmosphere-data-driven method for specifying an a priori flux distribution

# Bayesian hierarchical spatial model

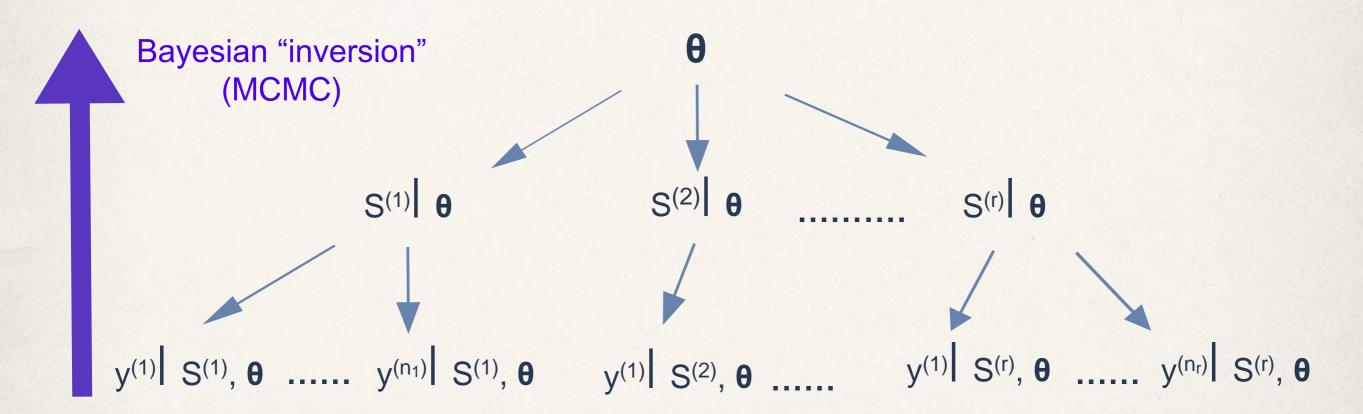
```
Bayes' rule

[process, params|data] 

[params]

× [process|params]

× [data|process, params]
```



y: observed carbon fluxes

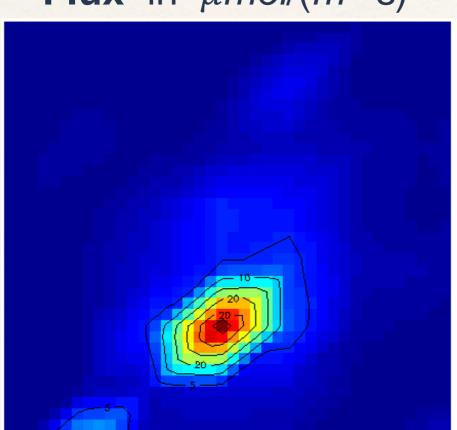
S: source strengths (Gaussian process)

 $\theta$ : params governing the magnitude and smoothness of the GP

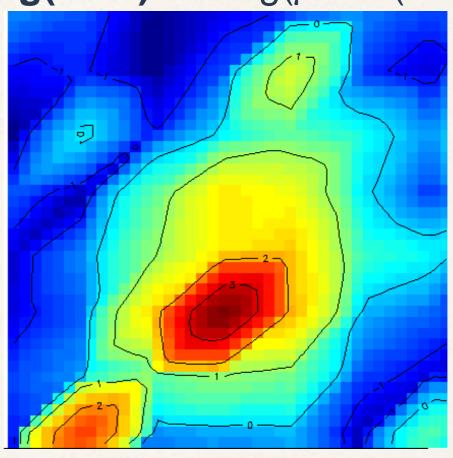


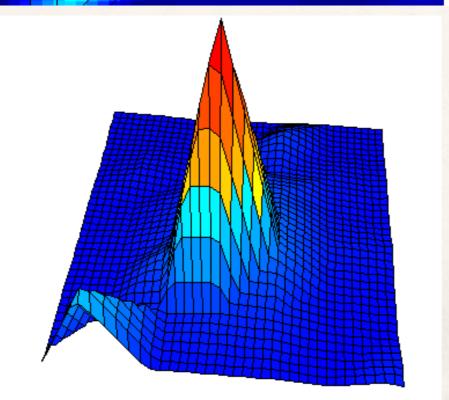
## **Vulcan Data**

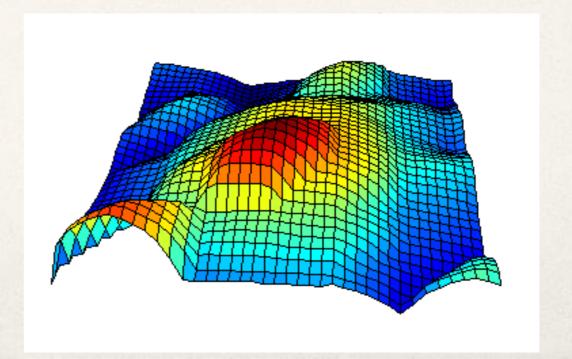
Flux in  $\mu mol/(m^2*s)$ 



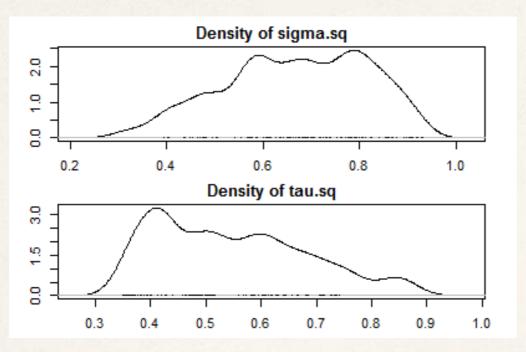
log(Flux) in  $log(\mu mol/(m^2*s))$ 

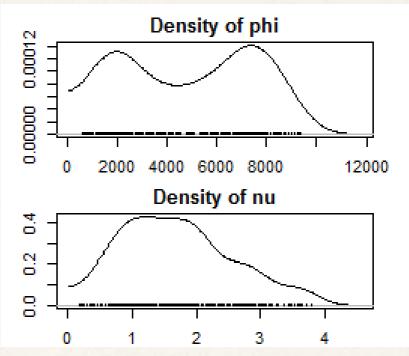


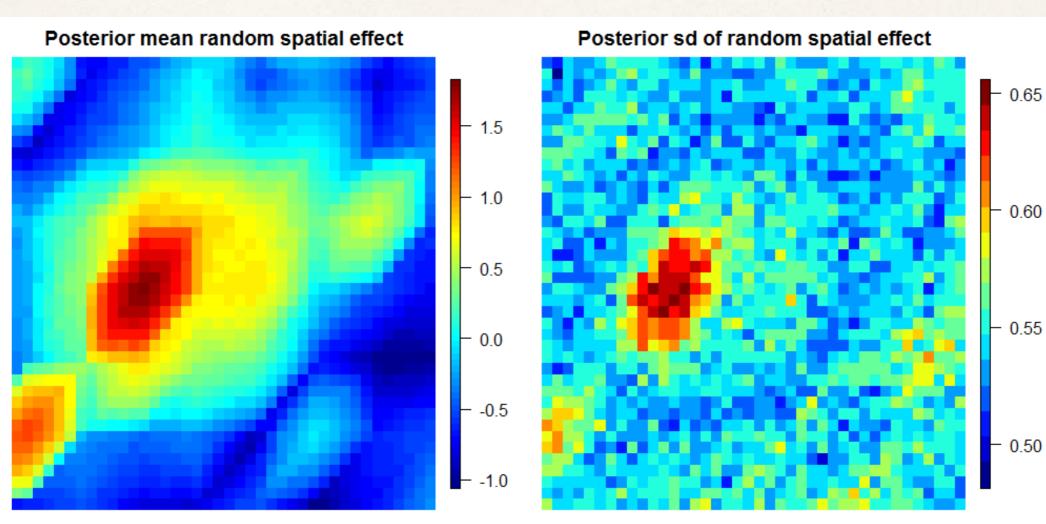




#### **Posterior results**

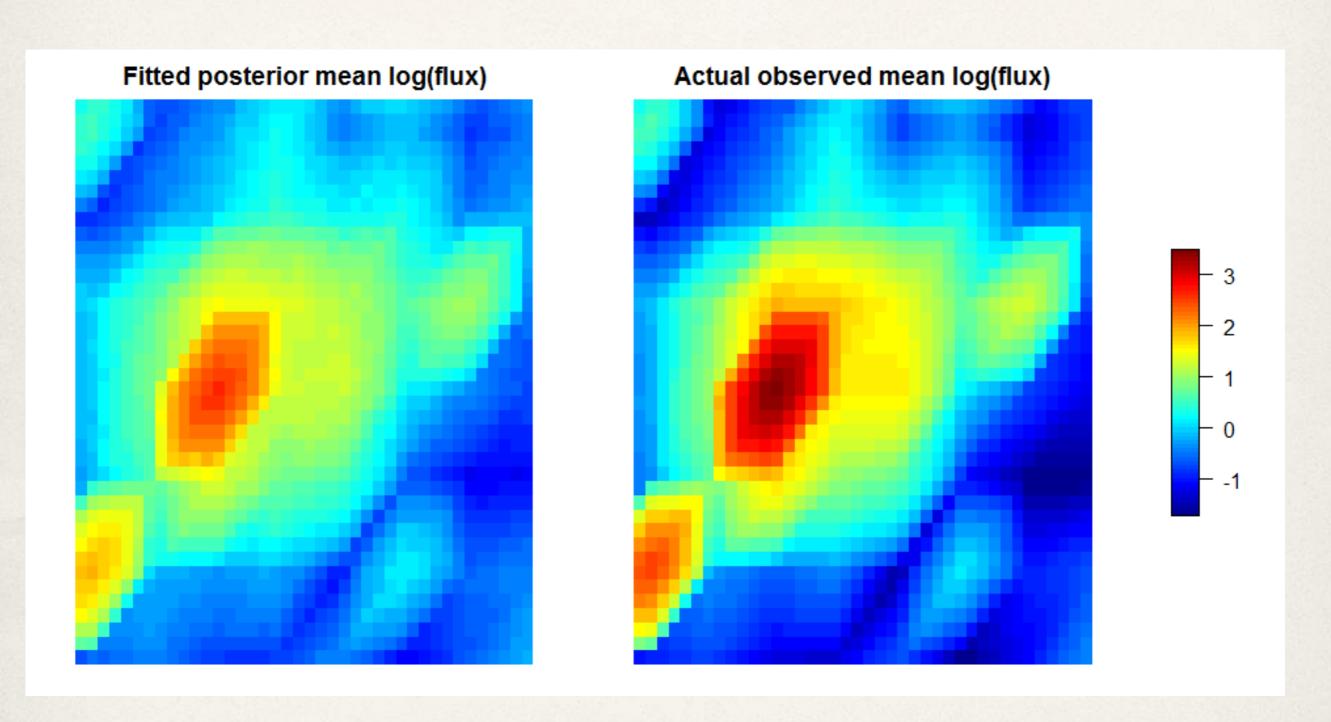






## **Fitted**

## **Actual**



# **Future directions**

Apply transport model to posterior fluxes to reproduce tower CO<sub>2</sub> concentrations

Scale up computations

Incorporate temporal information

Bayesian hierarchical GP model is clean, structured, and scientifically sound

grants full posterior distributions for critical model parameters

use in place of overconfident or ad hoc priors.

# Thank you!

- Israel Lopez-Coto (EL)
- Kuldeep Prasad (EL)
- Antonio Possolo (SED)

